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LINKS BETWEEN PRODUCTION SYSTEMS AND TRANSPORT: THE EXAMPLE OF GERMAN AND FRENCH INDUSTRIES

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ABSTRACT

Changes in transportation are closely linked to the economic and logistical characteristics of the production system. The aim of this paper is, on the basis of data on the economic context and surveys conducted in France (the 1988 Shipper survey and the 2004 ECHO survey) and in Germany (the 2005 DLR survey), to show the major changes that have occurred in the two countries at both micro- and macro-economic levels and how these have affected transport demand.

The first level of analysis relates to changes in the economic fabric. In particular, we have demonstrated the growing proportion of small and medium-sized firms at a time when large production units, which are those that are best able to concentrate their freight and use modes other than the road, are becoming fewer and fewer. At the same time, economic links are becoming more complex and, in the case of France, we have shown the increasing role played by wholesale traders in the distribution of goods. The constant reduction in transport costs and the opening up of markets is another structural factor whose impacts in both France and Germany we have also analysed. In addition to these economic changes, the internal modes of production of firms have also changed. Production is becoming more diversified and Just-in-time practices are spreading. The fragmentation of freight flows is thus occurring both in space and in time, which also has a major effect on the characteristics of the flows generated by firms and changes in transport. In the case of all these changes we have attempted to show the differences and similarities between the ways transport has changed in the two countries.

Keywords: changes in transport, production concepts, intra-firm transport, France, Germany

1. INTRODUCTION

Production, logistics and transport are closely linked systems with strong mutual impacts. Production concepts like Just-in-time or Just-in-sequence have changed demand for both logistics and transport. New logistical 'tools' such as containers have opened the way for new production concepts and heavily impacted international transportation. In addition the extension of the European motorway network in the last decades of the 20th century has led to greater reliance on trucks and facilitated the extension of the intra-European division of labour. In particular, it was expected that the change in production concepts with an ever-increasing division of labour and greater distances covered within supply chains would cause considerable growth in transport. While figures given on aggregate national or European levels seem to justify this expectation (e.g. Hummels 2006), there is still little empirical evidence for it at the level of individual sectors, branches or even firms. There is also a need for more detailed knowledge about the effects that changing production concepts have on the structure of transport demand.

With the aim of filling this gap, two surveys have been carried out independently in France and Germany. The French ECHO shipper survey (Enquête Envois - CHargeurs - Opérateurs de transport) was carried out by Inrets (the French National Institute for Transport and Safety Research) in 2004. This survey covered 2,950 sites in the industrial and wholesale trading sectors and followed a total of 9,700 shipments along the transportation chain in order to highlight the diversity and the complexity of transport with reference to the economic constraints that apply to the shippers and the characteristics of their shipments. The German survey, which was initiated by the DLR Transport Research Institute (DLR = German Aerospace Centre) was a representative study of the situation in Germany, investigated the volume and organisation of transport in more than 900 firms in the manufacturing sector.

Both surveys were founded on the general hypothesis of strong linkage between production, logistics and transport as has been explored by several previous studies. Haubold (1995) and Jäcker (1997), for instance, analysed the impact that outsourcing in the framework of modular production concepts has had on the transport demand of enterprises. In the case of the German electronics industry, Jäcker concluded that concepts like "lean management" or "computer integrated manufacturing" lead to an increase of up to 85% in truck use and truck mileage for the firms in question. Schamp (2000) demonstrated the fragmentation and spatial extension of supply chains in the automobile industry. He concluded that – in contrast to previous expectations – production concepts like Just-in-time or modular sourcing had not increased the number of regional production complexes, but had led to a significant increase in transport demand. In the case of the food industry, Meunier-Blanquart (2003) has shown the links between transport needs and the kind of relationship that exists between the members of the supply chain: authority, encouragement or trust (Baudry, 1995). Thus, transport needs are more complex for interactions that are based on trust, while interactions that are based on authority lead to flows that are organised in a simple manner that is determined by optimisation on the basis of cost. The adoption of Just-in-time practices and more complex logistical organisation is therefore not the outcome of a free strategic choice

but rather the result of the firm's position in the chain. In this case, because of their complexity and specialised nature, logistical services are completely outsourced. Cost is still a factor, but the shippers impose a broader quality-related goal on their service providers, for example security (punctuality, tracking of freight) and flexibility (reactivity, ability to respond to urgent demands).

Although the ECHO and DLR studies used different methodologies, comparisons are possible in several areas. For example, the production process can be analysed with reference to the size and the activity of the firms and the technical complexity and specialised nature of the products. Both surveys highlight the role of Just-In-time and storage practices, customer relations and spatial aspects of exchanges. These characteristics can be linked to the transport modes used and the volumes of goods transported. The measurement units may differ, in particular for transported volumes which are measured in tonnes or the annual number of consignments in the ECHO survey while the DLR survey considers the number of trucks loaded daily. However, the purpose is the same, namely to evaluate how the production system and spatial organisation affect transport demand and transported volumes. The studies also focused on ongoing changes, particularly the DLR survey which asked respondents about the changes that had occurred in the last five or ten years or those they anticipate in the short and medium terms. The ECHO survey did not directly question its respondents about these changes but it is possible to identify the trends by making comparisons with an earlier shipper survey dating from 1988 that considered the same themes. The observation methods and periods differ, but here too it is possible to compare the economic and logistical changes that have occurred and their impact on transport in the two countries.

This article will demonstrate the particular link between production and transport demand at the sector and enterprise level and the structural tendencies which emerge from these surveys. In order to be able to understand the national context in which the changes in question are taking place, we will start by giving some figures on the structures of enterprises and production and changes in transport in France and Germany. The next sections will present the results obtained from the two surveys. After a description of the common scope that has been adopted for comparisons between France and Germany, we will present an analysis of how the surveyed enterprises have developed in recent years and the consequences of this on transported volumes and the structure of transport demand. When, subsequently, we describe the relationship between production concepts, transport demand and the organisation of transport, we will focus on the impact of Just-in-time concepts on transport demand, warehousing practices and modal choice. At the same time we will make clear the methodological differences between the studies in order to ensure the comparison of findings is interpreted correctly.

2. THE ECONOMIC AND TRANSPORT PROFILES OF THE TWO COUNTRIES

2.1 Macroeconomic position

These two countries are geographical neighbours and both are major economic powers in the 27 member European Union (EU-27) of which they were founding members. The economic indicators set out in Table 1 were obtained from Eurostat data – most of them referring to the year 2007. They provide us with data that are as homogeneous as possible in order to compare the two countries with each other and with the other countries in the European Union. In terms of GDP (Gross Domestic Product) Germany is the greatest economic power, while France is in third position after the United Kingdom. France has a greater surface area than Germany but a smaller population (metropolitan France has a population of 61.5 million compared to Germany's 82.3 million) and the two countries have similar per capita GDPs in Euros or purchasing power standard. The other indicators that describe the profile of the two countries show a high unemployment rate (slightly over 8%) and higher values for the flexibility indicators (part-time working, having two jobs) in Germany than in France. The high labour costs in most economically advanced countries are a competitiveness factor that acts against them. Compared to EU member countries as a whole, hourly labour costs are higher than the average in both countries, and higher in France than in Germany, with shorter working hours. Productivity is, however, higher than average in the two countries and higher in France than Germany.

Table 1 - Economic indicators: Germany, France and the rest of the European Union.

	Germany	France	UE-27
Surface area (km$^{2)}$ Proportion of UE-27	357,021 8.3%	547,030$^{(1)}$ 12.6%	4,324,732 100%
Population 2007 (millions) Proportion of UE-27	82.3 16.6%	61.5,$^{(1)}$ 12.4%	495.1 100%
GDP 2007 (in current market prices, billion Euros) Share of UE-27 Per capita GDP in current market prices, 2007 (Euros) Per capita GDP in Purchasing Power Standard, 2007	2,423 19.7% 29,500 28,100	1,892 15.4% 29,800 27,600	12,304 100% 24,800 24800
Unemployment rate, 2007 (2)	8.4%	8.3%	7.1%
Persons working part time, 2007 (2)	26.0%	17.2%	18.2%
Persons with second job, 2007 (2)	3.8%	3.1%	3,9%
Earnings in industry and services , 2005 (3)	41694	30,521	28,992
Average hourly labour costs (3)	2006: 27.70	2006: 30.31	2005: 20.35
Labour productivity per person employed, 2007 (based on a PPS series EU-27= 100)	105.7	124.3	100
Labour productivity per hour worked, 2006 (based on a PPS series EU-27= 100)	110.9	119.5	87.8

(1) Metropolitan France without overseas Departments.
(2) Percentage of total population aged over 15 years
(3) Employees working full time in firms with 10 or more employees in the industrial and service sectors.
Sources: http://ec.europa.eu/consumers/ Profiles of European countries, Eurostat Statistical Yearbook 2009

The annual growth rate in real GDP for the European Union as a whole during the period 1998-2007 (Figure 1) provides an interesting supplement to these data, showing the dynamic development in recent years. Growth, which stood at approximately 3% at the end of the

1990s, slowed dramatically at the start of the new millennium with rates of about 1% in 2002 and 2003 before rising again to around 3% in 2006 and 2007, before the current economic crisis. The two surveys which were carried out in 2004 (the ECHO survey) and 2005 (the DLR survey) thus took place in a period of moderate and variable growth, which Eurostat has estimated at about 2.5% and 1.9% per year in 2004 and 2005 for the entire European Union, and which the IMF (International Monetary Fund) has estimated as standing at 2% for France in 2004 and 0.8% for Germany in 2005 (IMF 2007).

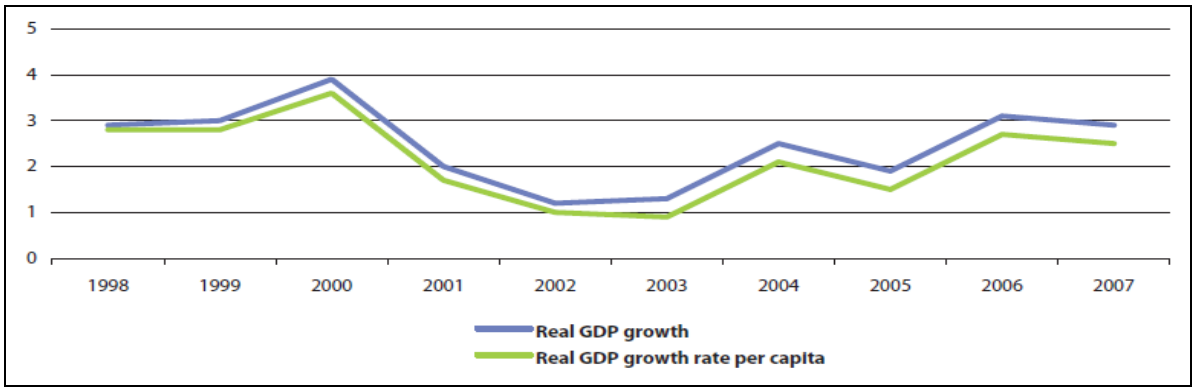


Figure 1 - Growth in real GDP, EU-27 (% change compared with previous year). Eurostat Statistical Yearbook 2009

Both Germany and France exhibit rapid growth in international trade, in common with all the countries in the European Union. There are nevertheless major differences due to the structure of their economies and in terms of competitiveness. Foreign trade in goods is an essential component of the German economy. In 2007, exports accounted for 41% of national GDP, and the balance of exports and imports was very positive, standing at 8%. The percentage of French exports, although rising, was very much lower, and in 2007 represented only 21% of national GDP, while the balance of trade deficit has been running at 2% since 2004. In the case of services (transport, travel, financial and corporate services, etc.) the position is the other way round with a slightly positive balance of trade in 2007 for France (0.7%) and a negative balance for Germany (1.3%). The European market is still the largest for both goods and services both for Germany where intra-community trade accounts for 57% of service transactions and 65% of goods transactions, and France where these figures are respectively 52% for services and 67% for goods. Outside the EU, the United States is still the main partner for services (debits and credits) as well as the export of goods. However, China has now become the major source of imports.

The decline in industry and the growth in services is one of the striking changes that is taking place in the European economy, even if manufacturing production remains a driving force of prosperity. In this connection, Table 2 shows the observed changes for the major sectors of the economy during the period 1997-2007 using as an indicator the percentage contribution of each sector to total gross value added. Taking the European Union as a whole, industry's contribution has fallen from 23.3% to 20.2%. This drop also applies to agriculture and has mainly occurred to the advantage of corporate and financial services. The differences between individual countries are considerable in this area too, particularly between France and Germany. Germany's economic structure has changed relatively little, with industry's

contribution even growing from 25 to 26% of national value added. In contrast, deindustrialisation is a major phenomenon in France. This began in the 1970s and has continued in recent years, with, in 2007, industry accounting for just 14% of national gross value added, or 21% if building is included, while the tertiary sector, trade and services, accounted for 77% of national value added (69% in Germany).

Table 2 - Change in the structure of activities (in percent of gross value added) between 1997 and 2007

	Germany		France		EU-27	
	1997	2007	1997	2007	1997	2007
- Agriculture, hunting and fishing	1.3	0.9	3.2	2.2	2.8	1.9
- Industry	25.1	26.4	18.4	14.1	23.3	20.2
- Construction	6.0	4.0	5.1	6.5	5.6	6.3
- Trade, transport and communication services	17.8	17.6	19.1	18.7	21.3	21.2
- Corporate and financial services	27.3	29.2	29.4	33.3	24.9	28.2
- Other services (public administration, education, healthcare …other collective and personal services)	22.6	21.9	24.8	25.3	22.2	22.3
Total	100%	100%	100%	100%	100%	100%

Source: Eurostat Statistical Yearbook 2009

The breakdown by enterprise size class also provides valuable information on the structure of the economy. Analyses conducted in France (Moati, 2002) have shown that the number of very large enterprises stopped increasing in the 1980s and then began to fall, initially to the advantage of smaller enterprises with between 10 and 499 employees, and then, in the 1990s, to the advantage of micro-enterprises with less than 10 employees. Table 3 displays this change for France and Germany over a more recent period, 1999-2004. The statistics given in this table relate solely to the market economy designated by the term “non-financial business economy” in the European statistics or “ICS field” in France. They cover industries, distribution and corporate services apart from the agricultural sector, financial services and public administration. The table also excludes the enterprises without employees or people like doctors, architects, etc. which do not feature in the German statistics.

Table 3 – Enterprises in France and Germany by size class 1999 and 2004

Number of employees	Number of firms							
	Germany				France			
	1999		2004		1999		2004	
	thousand	%	thousand	%	thousand	%	thousand	%
1 to 9	1,729	80.6%	1,660	80.7%	1,038	86.3%	930	83.6%
10 to 49	332	15.5%	312	15.2%	137	11.4%	153	13.8%
50 to 499	80	3.7%	79	3.9%	25	2.1%	27	2.5%
≥ 500	5	0.2%	5	0.2%	2	0.2%	2	0.2%
Total	2,146	100%	2,056	100%	1,202	100%	1,113	100%

Sources: Germany: own calculations based on a 50% sample of data from the German National Employment Agency (Bundesagentur fuer Arbeit)
France: INSEE 2000-2005 -. Annuaires statistiques (Sirene, champ ICS)

The changes that have occurred in France are less marked during this period than in the past and are characterized by a resurgence of enterprises with between 10 and 499 employees, while the number of very large enterprises remains stable. Enterprises with between 1 and 9 employees are falling in number, but the number of enterprises with no employees, which are not considered in this table, is nevertheless continuing to rise. The changes observed in Germany over this period are relatively minor. The number of firms has fallen in the smallest size class (between 1 and 49 employees) while remaining fairly stable

in the larger size classes while the overall structure has remained unchanged. Very typical for the German firm structure is the relatively high number of enterprises in the 10 to 49 and 50 to 499 employee classes, which are broadly equivalent to the so-called German "Mittelstand".

In both countries, as for Europe as a whole, small and medium-sized enterprises have become a vital part of the economy. They have an important role to play in creating jobs and value added. They account for two-thirds (67%) of all the jobs in Europe and 58% of the total value added. The figures are slightly lower, but still quite high for France and Germany, where these enterprises provide approximately 60% of the jobs.

To conclude this examination of the macro-economic context, we shall highlight the differences in the spatial distribution of economic activities in France and Germany due to their historical development and their current political systems. While France is still characterised by a high degree of centralisation, economic activities in Germany are spread throughout the country, albeit with a degree of concentration in the western parts of the country where production hotspots are found in the south and the west (Figure 2).

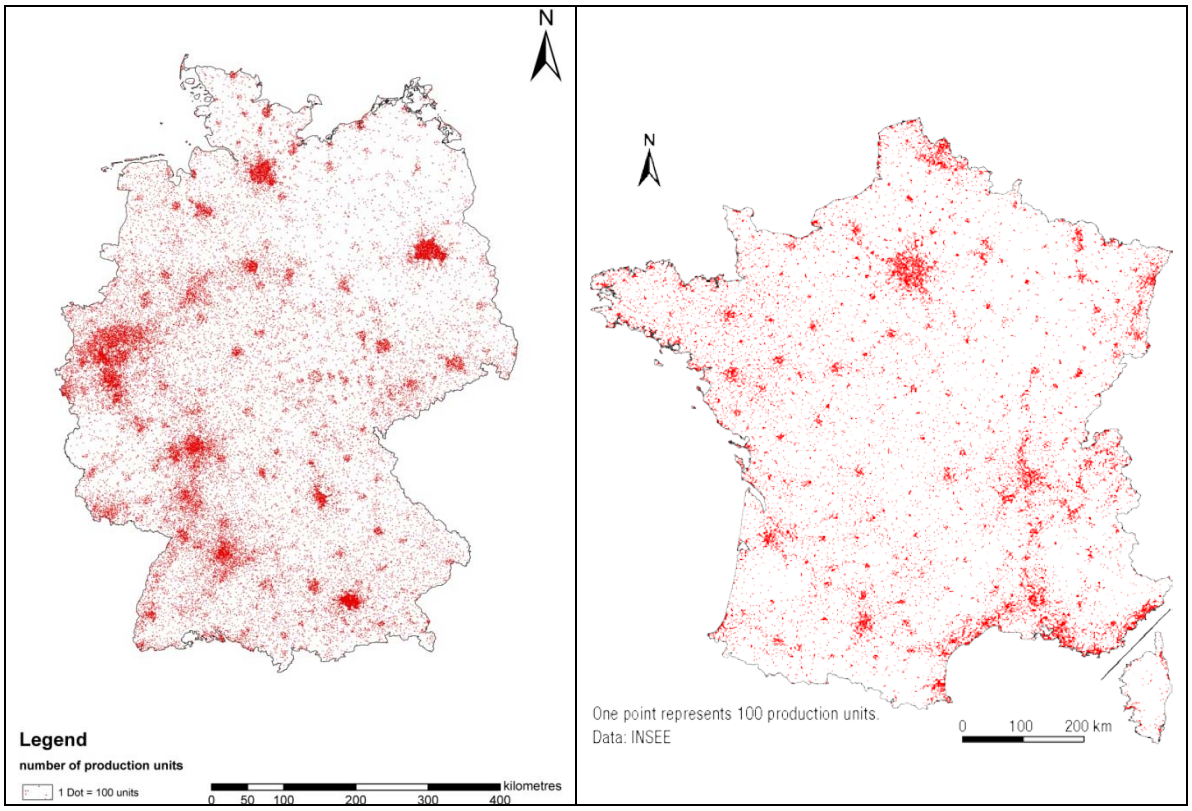


Figure 2 – Distribution of production units across France and Germany. Map by DLR and Inrets.

2.2 The transport context

2.2.1 France

Freight traffic volumes in France, as elsewhere in Europe, are to a large degree linked to economic activity and reflect, and even frequently amplify, fluctuations in the economic climate. This is particularly clear if we compare change in GDP at constant prices with domestic freight transport volumes in tonne-kilometres (Figure 3).

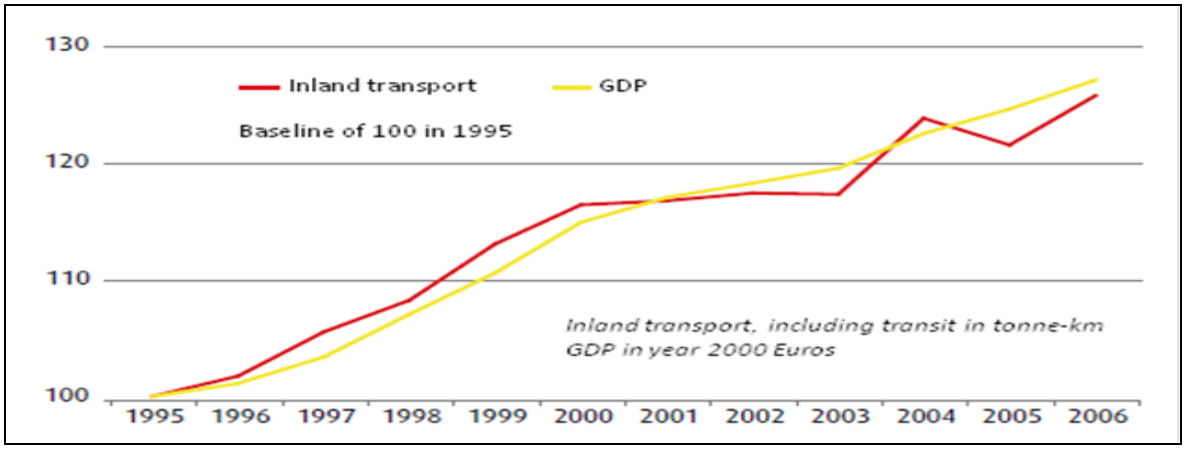


Figure 3 – GDP versus domestic freight transport. CGDD (2009a)

Inland transport (domestic traffic and that part of import and export journeys that takes place inside France's borders and which is transported by French carriers) has increased by approximately 24% over a 15-year period and stood at 238.6 billion tonne-kilometres in 2005 (Table 4). Road transport is the major contributor to this traffic (81%) and its share has been rising constantly. Its position contrasts with that of rail, whose share of traffic and volumes have fallen (Figure 4). The waterways carry much less traffic than the other two modes (5 billion tonne-kilometres, i.e. 2% of the total) in spite of the evident size of the waterways network. Waterborne transport suffers from of a lack of wide waterways and above all of the absence of connections between different basins.

Table 4– France, inland transport in tonne-kilometres

	1990		2005	
	tonne-kilometres		tonne-kilometres	
Transport mode	billion	percent	billion	percent
Rail	51.5	26.6%	40.7	17.1%
Road	137.0	70.8%	192.9	80.8%
Waterways	4.9	2.5%	5.0	2.1%
Total	193.4	100.0%	238.6	100.0%

Reconstitution based on the retrapolation of SOeS/ SitraM series (CGDD 2009b)
Domestic transport and that part of import and export journeys inside French borders, French carriers only

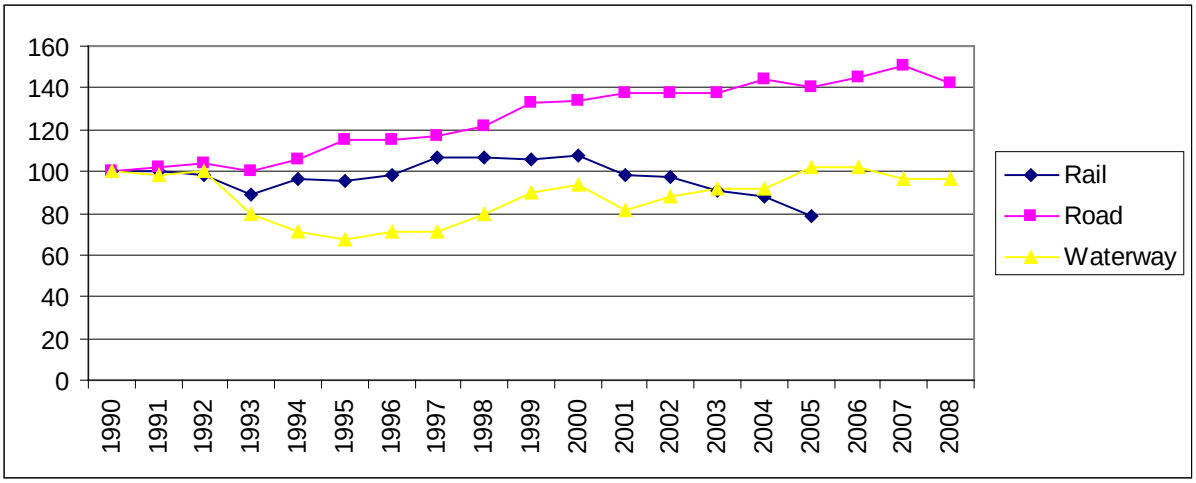


Figure 4 - France, inland domestic traffic carried by the different modes (CGDD, 2009). Reconstitution based on the retrapolation of SOeS/ SitraM series Domestic transport and that part of import and export journeys inside French borders, French carriers only. Traffic in tonne kilometres, baseline of 100 in 1990

As in the case for waterways, the political will for developing rail exists, but the difficulties encountered are structural in nature and caused by the logistical changes that are taking place in firms and changes in the nature of products. Deindustrialisation has been accompanied by a change in the emphasis of production towards goods with higher value added that are more technologically advanced. Most of the growth that has occurred is in the manufacturing sector while intermediate goods and agro-foodstuffs, which are the traditional markets for rail and waterways transport, have grown only very slightly (Figure 5).

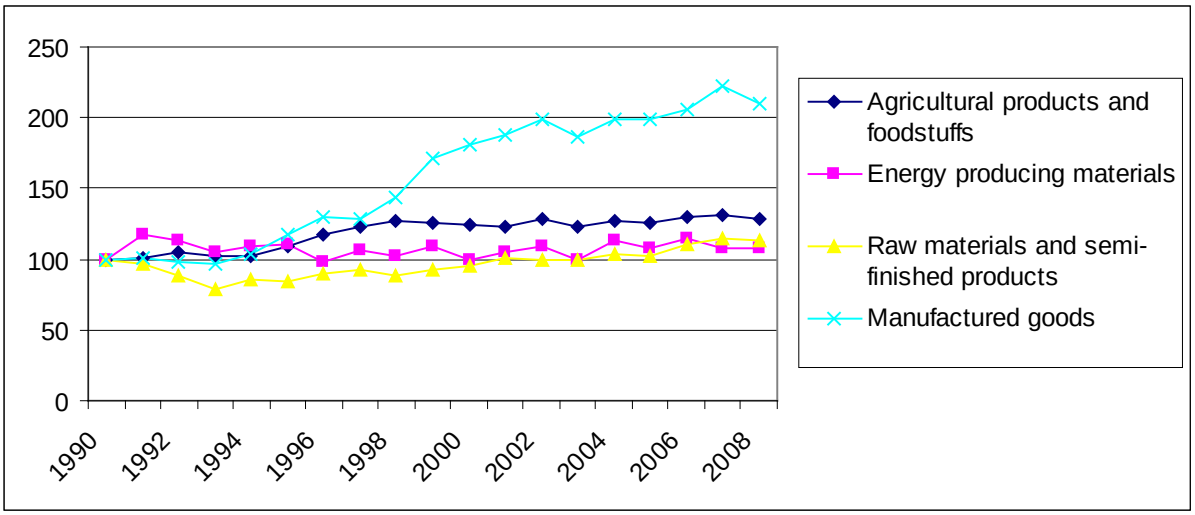


Figure 5 - France, tonnages transported by road according to the nature of the goods. Reconstitution based on the retrapolation of SOeS/ TRM series (CGDD, 2009)

International traffic accounts for a large share of inland freight transport. In tonne-kilometres, it represented 26% of all the freight transported in France by French or foreign carriers in 2007 (CGDD 2010). Maritime transport is also growing rapidly. An idea of its scale is given by the volume of freight it handled in 2007, i.e. a total of 384 million tonnes for all the ports of

mainland France. Air transport's share is much lower, representing 1.8 million tonnes in 2007, but the value of the goods carried is high and the amount of traffic is on the increase.

The lengthening of distances is frequently mentioned in connection with the development of trade and the opening up of borders. In the case of France, this increase in distances was particularly marked between 1975 and 1995. The average distance for all types of freight and each of the three inland transport modes increased by 37.5%, rising from 72 km to 99 km (Savin, 2000). Since 1995, change has been much less marked as illustrated in Figure 6 for inland road distances. The tendency, at least for France, has even been one of stagnating domestic road distances, with the beginning of a decline probably due to the economic slowdown. Here too, the changes in distance should be seen against the background of changes in the structure of the economy and the general nature of logistics. The decline in the proportion of intermediate goods, which are generally transported short distances has contributed to the lengthening of distances. The more recent reduction in consignment sizes and the increase in the complexity of transport chains with more journeys for a same origin-destination shipment can leads to an artificial reduction in the calculated distances.

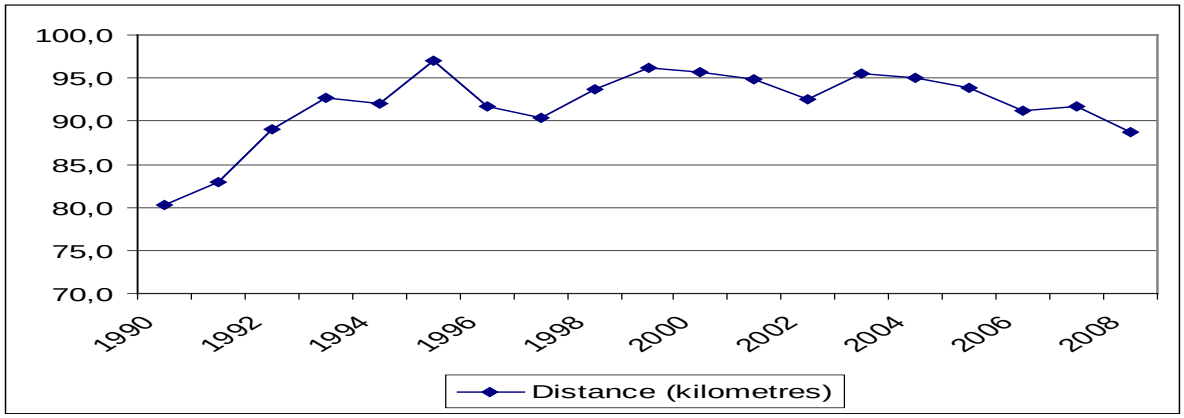


Figure 6 – France, road distances. Reconstitution based on the retrapolation of SOeS/ TRM series of French inland tonnes and tonnes kilometres

2.2.2 Germany

National transport which also includes transit through Germany underwent important changes between 1991 and 2005 (Table 5). While the total amount of freight measured in tonnes decreased between 1991 and 2005, the number of tonne-kilometres increased considerably: Tonnages dropped by almost 10%, while the number of tonne-kilometres rose by 45%. This can be interpreted as a significant indicator of the increasing division of labour producing additional transport demand.

Due to Germany's geographical position in Europe the particular role of transit freight between East and West or Southern Europe has to be considered in this context: Transit freight accounts for a steadily increasing proportion of freight transport in Germany. While in 1991, only 150.1 million tonnes were transported through Germany, by 2005 this figure has more than doubled to stand at 321 million tonnes.

Table 5– Germany, national transport in tonnes and tonne-kilometres (including freight transit)

	Tons				Ton-kilometres			
	1991		2005		1991		2005	
	million	%	million	%	billion	%	billion	%
Railway	415.5	11.3	317.3	8.5	82.2	16.4	95.4	16.5
Road	2,918.7	79.9	3062.1	82.5	245.7	64.9	402.7	69.6
Inland waterways	230.0	6.3	236.8	6.4	56.0	14.9	64.1	11.1
Pipelines	90.7	2.5	95.5	2.6	15.7	3.9	16.7	2.9
Total	3,654.9	100	3,711.7	100.0	399.6	100.0	578.9	100.0

* without cabotage ; without truck transport carried out by railway companies
Data source: Verkehr in Zahlen 2007-2008, for 1991 based on calculations of DIW (Deutsches Institut fuer Wirtschaftsforschung)

It has to be pointed out that local transport, i.e. up to a distance of 50 kilometres, accounts for a large percentage of the national freight volumes transported by truck. In 1991, 2,185 million of a total of 2,768 million tonnes of truck freight were “local” transport, i.e. 75%; in 2005 this proportion was still 58% (data source: Verkehr in Zahlen 2007-2008). Table 6 reveals the importance of so-called “local” transport for both third party transport, i.e. transport organised by a transport company, and own account transport, i.e. transport organised by a production or trade company for their own purposes. All the figures in this section are for freight carried by German-owned trucks. While the total truck freight on German roads in 1991 amounted 2,919 million tonnes, at that time, of course, still without cabotage; in 2005 it stood at 3,062 million tonnes, 16.9 million of which was cabotage transport.

Table 6– Germany, national transport in tonnes according to distance category, for 2006 (only trucks owned by German owners)

	Third party transport		Own account transport		Total	
Distance class (km)	million tonnes	percent	million tonnes	percent	million tonnes	percent
Less than 50	841.7	48.3	827.8	71.5	1,669.5	57.6
51 to 100	228.8	13.1	149.8	12.9	378.6	13.1
101 to 150	141.6	8.1	69.2	6.0	210.8	7.3
151 to 500	400.5	23.0	99.6	8.6	500.1	17.3
501 and over	128.6	7.4	11.2	1.0	139.8	4.8
Total	1,741.1	100.0	1,157.7	100.0	2,898.8	100.0

Data source: Verkehr in Zahlen 2008-2009

As for France, the truck is by far the most important freight transport mode with shares that are still rising. From the total of 439 billion truck ton-kilometres in 2006 a considerable amount is made by trucks that have foreign owners (33.1% for foreign trucks, 66.9% for trucks owned by German owners; data source: Verkehr in Zahlen 2008-2009). The share of freight transport by rail is also comparable to that in France, but shows an increase for Germany in the near past.

Building materials are the most important product for truck transport in Germany; in 2005 they represented 47% of total freight tonnages transported by trucks. In the first years after German reunification, this figure rose to almost 60%. While fewer building materials are transported today, both in relative and absolute terms (1,284 million tonnes in 2005 compared to 1,711 million tonnes in 1997), there is a broad range of products for which truck transport has become increasingly important. These include, in particular, intermediary

products where the absolute figures rose from 353 million tonnes in 1997 to 527 million tonnes in 2005 (data source: Verkehr in Zahlen 2007-2008. In tonne-kilometres, however, cars, machines, and intermediary products account for by far the most transport which highlights the intensive division of labour in this sector (Figure 7).

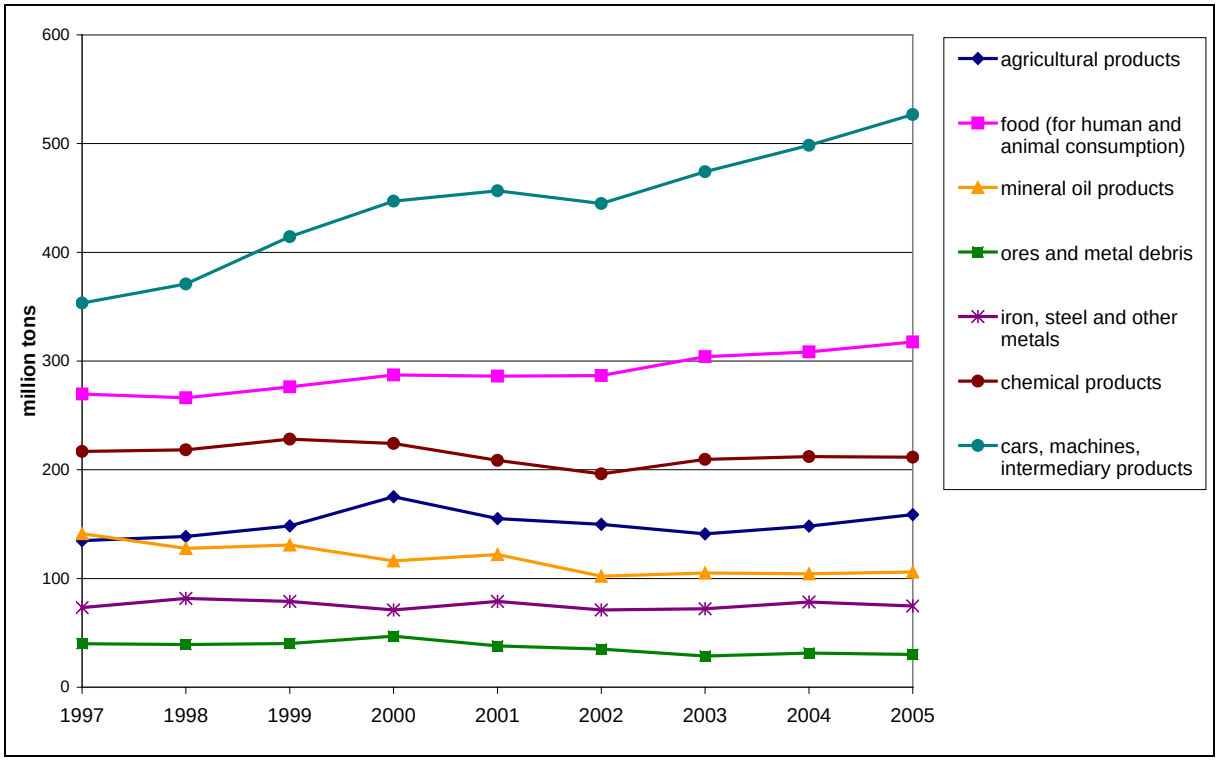


Figure 7 – Germany, development of truck ton by selected goods. Data source: Verkehr in Zahlen 2007-2008

In Germany, the maritime sector is also growing rapidly, for a large degree due to the containerisation of freight. In 2005, the total amount of cargo handled was 284.9 million tonnes, of which 130.7 million tonnes were bulk materials and 154.1 million tonnes piece goods. This means that the total amount of cargo passing through German ports increased by 57.5% from 1991 to 2005. In 1991 28.4 million tonnes out of a total amount of cargo handled of 163.9 million tonnes (3.731 million TEU) was container freight. This figure rose to 98.8 million tonnes (12.101 million TEU) in 2005.

The size of the air freight sector doubled from 1991 to 2005 with 1.561 million tonnes in 1991 compared to 3.036 million tonnes in 2005. Today air freight accounts for only 1% of the total freight in terms of tonnage, but about 40% in terms of value (Heymann 2008). In this connection, Boeing have stated that products that have a value-to-weight relation of 16 USD per kilogram or over tend to be transported by air (Boeing 2006).

During the period 1997 to 2005 we have observed an increase in the average transport distances for almost all products transported by truck (Figure 8), the only exception being fertilisers. However, as already stated for France, these figures only cover that part of the journey which was within Germany's borders and ignore journeys beyond them.

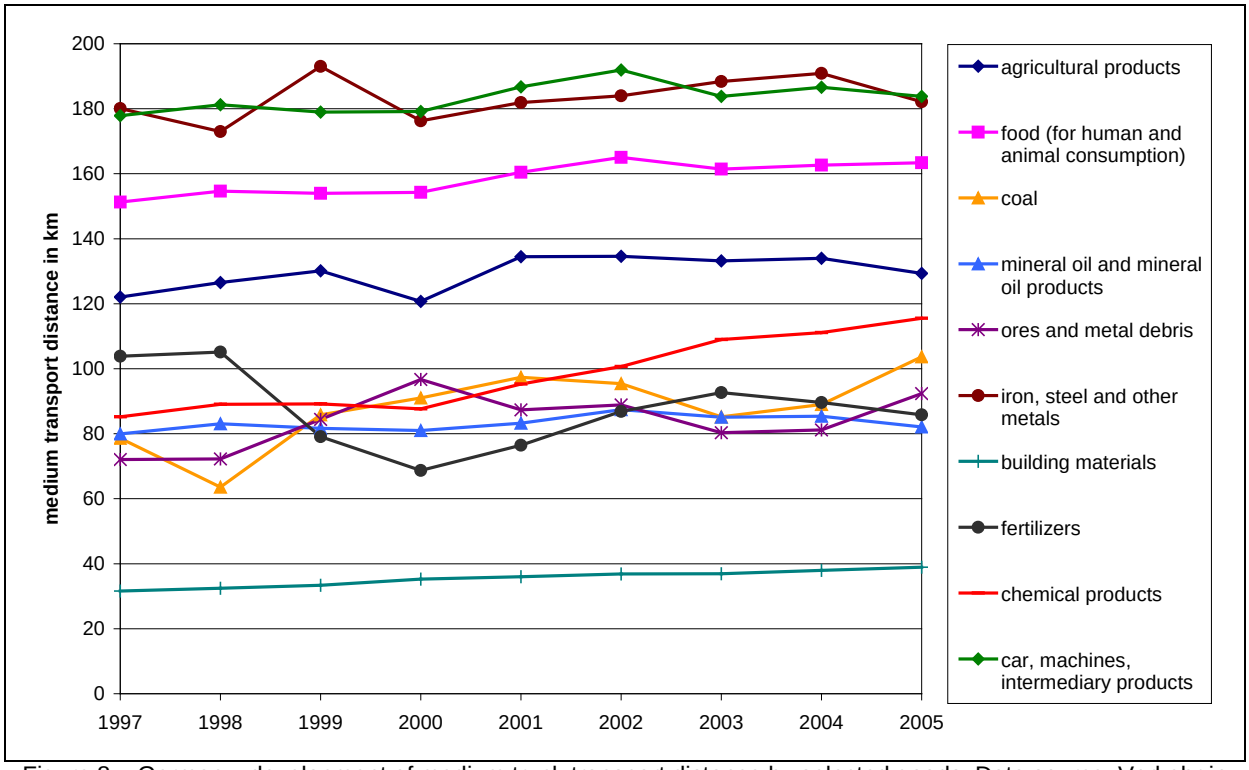


Figure 8 – Germany, development of medium truck transport distance by selected goods**.** Data source: Verkehr in Zahlen 2007-2008

3. SCOPE OF ANALYSIS OF THE TWO SURVEYS

The results presented in the following sections relate to the manufacturing industries in the two countries (NACE codes[1] 15 to 37). In both cases, the observation unit is the “site” rather than the “enterprise”. An enterprise can therefore have several geographically separate, but legally dependent, sites of production (1.16 sites on average per enterprise in France for the entire 2004 ICS field). In view of the importance of the spatial dimension of transport, we felt that it was preferable to use this geographical level of production and transport flow generation even if some decisions may be taken at a higher level in the enterprise or economic or financial group. It also has the advantage of being more coherent with production practices. However, a great deal of attention was given to making sure that the individuals who were interviewed had a good understanding of the strategic policy of the site and the enterprise it belongs to.

Like enterprises, sites may have a number of activities, and the surveys describe this diversity. However, the sampling plan was drawn up on the basis of the principal activity (i.e. that which generates the largest turnover) and the same applies to the main results presented here which involve analyses according to the sector of activity rather than for each branch.

[1] Statistical classification of economic activities in the European Community Rev. 1.1

We have also introduced size criteria for the site or the enterprise, unfortunately these are not strictly equivalent in the two countries as a result of differences in the sampling bases that are available. The results of the ECHO survey relate to all establishments with 10 or more employees that have been identified from the SIRET register maintained by INSEE (the French statistical institute), which lists all sites. In the case of Germany, which does not have a complete register of sites that can be used for surveys, we have used the Hoppenstedt database which only contains firms with an annual turnover of at least one million Euros or which employ at least 20 employees. In case of companies with a number of sites (37% of cases) the interview was held at that with the highest production volumes. The sites covered by the DLR survey can therefore have fewer than 10 employees, but on the other hand some sites with 10 or more employees are not covered by the study as their enterprise has less than 20 employees and turnover of less than 1 million Euros. The population of enterprises with between 10 and 19 employees is therefore not strictly comparable in the two countries. Nevertheless, we have retained this size class in view of its importance in terms of the number of sites and the interest of comparisons with the other employee size classes, which remain valid within both countries.

The random sample selected in both surveys was a disproportional stratified random sample weighted in favour of larger firms. In Germany stratification was performed on the basis of enterprise size (up to 49 employees, 50-99 employees, 100-249 employees, 250 employees and more), sector according to NACE-code' (10, 20, 30) and region (north, east, west, south). In France it was selected on the basis of enterprise size (10-19 employees, 20-49, 50-499, 500-999, 1000 employees and more) and the sector of activity (39 groups constructed on the basis of the detailed NACEs); all metropolitan France was considered, without any other geographical criterion. The survey samples that belong to the common scope used in this paper account respectively for 2,056 sites (ECHO) and 907 sites (DLR). The results that are given for the two countries have been weighted in order to reproduce the true structure of the populations in the survey in terms activity, size and region. In the case of France, the weighting was carried out on the basis of the total population the sample was intended to represent, i.e. 45,298 sites. In the case of Germany, the weighting was conducted on the basis of the sample and the results were presented for 907 sites; the corresponding total population is estimated at approximately 38,000 enterprises and 46,000 sites.

The last point we would like to stress relates to the activities which have not been studied. They define the scope of the study just as much as those that have been selected, and this should not be forgotten when interpreting the results:

- agriculture and the mining industries (unprocessed ores and minerals) that tend to involve heavy bulk transport;
- wholesale traders and warehouses, which are covered by the ECHO study but not by the DLR survey;
- retail traders and other services as well as small sites with fewer than 10 employees;

Nevertheless, the scope that is studied is very large and covers a major proportion of the estimated traffic. In France, that part accounts for approximately 36% of total shipped

tonnages (domestic and export consignments) and approximately 64% of total shipped tonnages other than agricultural materials, ores and minerals.

4. LINKS BETWEEN MACRO-ECONOMIC DEVELOPMENTS AND TRANSPORTS

The macro-economic developments that have been outlined above are related to the transition from an economic model that is characterized by large production units to economic models that are more fragmented and more hybrid in nature. This change modifies the nature of the products that are manufactured and the production process which makes use of flexible, multi-site, coordinated modes of organization. Economic links are becoming more complex and new types of structure are developing with more intermediaries and service activities and an increase in freight movements, particularly at an international level.

The section will attempt to show, based on our surveys, how these changes in the production system have affected transport. Our analyses will begin by considering the changes in the population of enterprises and the fragmentation of the economic fabric. They will allow us to see the relative scale of the traffic that is generated by enterprises of different sizes (small, medium-sized and large) and the changes that have been observed with regard to the consolidation of shipments. Using the ECHO survey, whose scope includes not only industry but also wholesale trading, we will also show the growing importance of these intermediaries with regard to structuring trade and traffic. The second level of analysis relates to the spatial scale of freight movements. The constant reduction in transport prices and the political opening up of markets have led to the geographical extension of freight movements, and here too we shall give some examples of the changes that have occurred in France and Germany.

4.1 The structure of the productive fabric and generated transport measured in tonnes and shipments

The transformations that have taken place in the productive fabric and the impacts they have had on the amounts of products that are transported can be illustrated by comparing the 1988 and 2004 French surveys. For this analysis we shall consider all manufacturing enterprises with 10 or more employees, excluding publishing, jewellery and recycling (NACEs 22, 362 and 37) which were not covered in 1988. In this connection, Figure 9 shows the increase in the proportion of small sites that took place in the 16 years that elapsed between the two surveys. The smallest enterprises, with 10-19 employees, have increased considerably in number while the number of enterprises has fallen in all the other size classes with the exception of those with between 250 and 499 employees. In particular, there has been a striking drop in the number of large sites with more than 500 employees: the number of these fell by 40% in the studied period and in 2004 there were fewer than such 800 sites left.

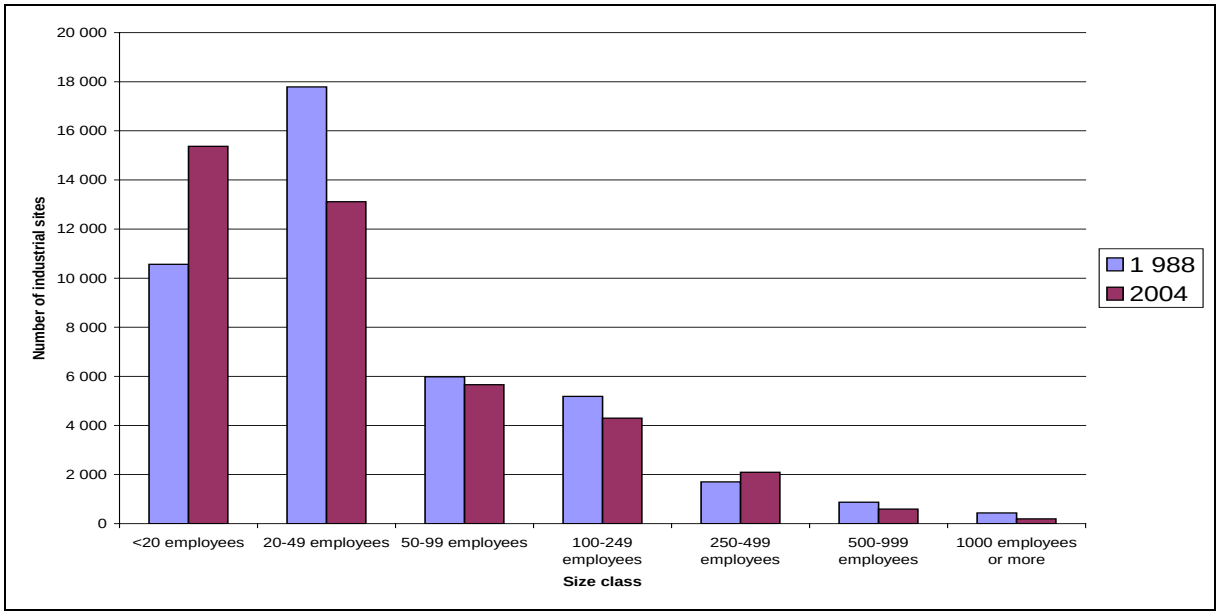


Figure 9 - France, change in the number of industrial sites by size class. Source: Inrets, 1988 Shipper Survey and 2004 ECHO survey. Sites with 10 or more employees belong to the manufacturing industries other than NACEs 22, 362 and 37)

Even if the more recent contextual factors presented in the second section would seem to show that the changes are slowing down, it is important to remember the fragmentation of the economic fabric which is made up of a large number of small production units. The small number of large industrial sites has a particularly important influence on the structure of the transport market insofar as it is often large sites that find it easier to consolidate their flows and dispatch large shipments that can be carried by rail or waterborne transport. This aspect is shown by Table 7 which shows the contribution of each enterprise size class – small, medium-sized and large industrial establishments – to the traffic that is generated in terms of tonnage and number of shipments.

Table 7 - France, percentage of small, medium-sized and large sites in the total population of sites and their respective contributions to generated traffic.

Sites' size	Number of sites	Tonnes	Shipments
Small sites (10-49 employees)	70%	29%	32%
Medium-sized sites (50-499 employees)	28%	55%	56%
Large sites (500 employees and +)	2%	16%	12%
Total	100% (45,228)	100% (564 million)	100% (265 million)

Source: Inrets, Echo survey 2004, all manufacturing industry

Using the tonnage/shipment ratio as an indicator, the fragmentation of flows appears to be linked to site size: the most fragmented flows are generated by the smallest sites (29% of tonnages for 32% of shipments) while the most consolidated flows are generated by large sites (16% of tonnages for 12% of shipments). In addition, it is noteworthy that small sites with between 10 and 49 employees account for 29% of total tonnages while sites with between 50 and 499 employees are responsible for more than half of total tonnages.

An analysis of changes with reference to type of activity is also highly instructive. While the general tendency during the period between the two surveys was for the number of sites

involved in all types of activity to increase, there was in contrast a drop in the number of industrial sites. This shift is a sign of the restructuring of activity that is taking place with industry giving way to the service sector and also has a major impact on transport. In this case, the changes are not linked to the nature of the transported products but to changes in the channels of supply and distribution. In this regard, wholesale and intermediary traders such as purchasing cooperatives, play an essential role in structuring transport flows. The ECHO survey, whose scope included these intermediaries, highlights the large scale of the generated flows, which in 2004 were estimated to include 60% of consignments and 39% of tonnages (Table 8). The contrasting manner in which shipments and tonnages changed in the period between the two surveys is also very striking. If we consider industry alone, tonnages increased more rapidly than the number of shipments (the percentage increases being 35% for tonnages and 22% for shipments). This trend is the opposite to that observed for wholesale traders whose traffic has increased much more rapidly for shipments than tonnages (54% for tonnages and 77% for shipments). The greater fragmentation of shipments that has been observed for the entire scope of the survey is thus essentially explained by changes in the practices of wholesale traders which act as hubs while industry has tended to consolidate its shipments.

Table 8 - Wholesale traders and commercial intermediaries as a percentage of traffic generated

	Tonnes			Shipments		
Activity	1988	2004	Change 2004/1988	1988	2004	Change 2004/1988
Industry						
thousands	391,171	529,384		209,040	255,874	
%	69%	61%	+35%	57%	40%	+22%
Wholesale traders						
thousands	178,597	343,886		155,050	388,541	
%	31%	39%	+93%	43%	60%	+151%
Total population						
thousands	569,769	873,270		364,090	644,415	
%	100%	100%	+53%	100%	100%	+77%

Source: Inrets, 1988 Shipper Survey and 2004 ECHO survey with the 1988 scope

The German survey is unable to provide any time series. The survey reflects trends solely on the basis of the firms' own estimations not by comparing time series. It is consequently more difficult to observe macro-economic changes directly. The data on generated transport volumes are also less detailed than for France and are not given in tonnages or the number of shipments but in terms of the regular loading and unloading of trucks. However, the analysis of these truck numbers with reference to the size of the site or the sector of activity still provides insights. Tables 9 and 10 show that the numbers of trucks being unloaded or loaded are quite considerable even in smaller firms; at the same time they reveal – as one would expect – that the volumes rise with the size of the firm. Higher numbers of daily trucks loads (loading and unloading) are found for firms producing agricultural and intermediary goods. At the same time we find high shares of piece goods in the production goods and consumer goods sectors while full loads characterize the agricultural sector and the intermediary goods sector (Table 11). When interpreting these data it has to be kept in mind that the type of load is related to different truck sizes.

Table 9 – Number of regular trucks unloaded according to the size of the firm

Number of trucks unloaded per day	Firm size by number of employees				
	1-19	20 - 49	50 - 499	500+	Total
	In percent				
less than one	40	22	10	2	19
1 to 10	59	68	72	53	68
11 to 50	0	9	17	41	13
51 and more	2	1	1	3	1
total	100	100	100	100	100

Source: 2005 DLR survey

Table 10 - Number of regular trucks loaded and unload ed trucks according to size of the firm

Number of trucks loaded per day	Firm size by number of employees				
	1-19	20 - 49	50 - 499	500+	Total
	In percent				
less than one	44	31	11	8	23
1 to 10	54	59	69	38	62
11 to 50		9	18	42	13
51 and more	2	1	2	13	1
total	100	100	100	100	100

Source: 2005 DLR survey

Table 11 – Type of load as share of the daily unloaded load, measured by median values for sectors of activities

Type of load as percentage of daily unloaded volumes	Firm's sector of activities				
	Intermediary goods	Production goods	Agricultural goods and food	Consumer goods	Total
	in percent				
full load	52	19	53	26	32
partial load	19	24	18	25	23
piece goods	29	57	29	49	45
total	100	100	100	100	100

Source: 2005 DLR survey

4.2 The spatial dimension of enterprise shipments

The spatial dimension of the shipments sent by enterprises is another important analysis theme covered by both surveys. It is nevertheless tackled in a markedly different manner. The German survey is thus particularly concerned with the relations with the enterprise's partners, suppliers and clients while the French survey places the emphasis on the configuration of their market areas. We shall present the case of Germany first by analysing the production networks to which the enterprises currently belong and how these networks have changed in recent years, in particular with respect to regional markets, on both the supply and the customer side. We shall then consider the example of France, showing the regional embeddedness of firms, which is still quite considerable, but also the opening up to international ties.

4.2.1 Germany

Supply side

The majority of firms do not have more than 50 suppliers, and of course, the larger the firm the more suppliers it tends to have (Table 12). In general, firms seem to have fairly stable relationship with their suppliers, as we do not find major changes either in the number of suppliers nor in the robustness of the ties. Across all firm sizes and all branches firms state that they cooperate for two or more years with more than 95% of their suppliers. At the same time, about half of the firms use several suppliers for the same product, so that the quantities purchased from a specific supplier might vary

Table 12 – Germany, number of suppliers by firm size

	number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
number of suppliers	shares in percent				
1 to 10	35	21	20	10	22
11 to 30	37	32	26	18	30
31 to 50	6	18	17	18	16
51 to 100	12	15	15	25	15
Share of firms with less than 100 suppliers	90	86	78	71	83

Source: 2005 DLR survey

Suppliers have become more important in the last 10 years: 27.4% of firms have changed to external procurement of parts that were formerly produced in-house by outsourcing and spatial fragmentation of their production. Another 14.2% of firms say they plan to engage in outsourcing and/or relocation in the foreseeable future. The main target areas for outsourcing and spatial transfers are Germany, Central and Eastern Europe and China. The importance of these target areas for a production shift now and in the future is reflected by the level of current and future outsourcing in the investigated firms (see Lenz, Menge 2009).

There is a highly significant correlation between firm size and the outsourcing of production. Larger firms are more involved in outsourcing than smaller ones. The same is true for planned outsourcing, even though the degree of correlation is somewhat lower. The main reasons for outsourcing are financial, in particular the lower production and wage costs in the target areas. Other reasons that firms mention are the lack of space for further growth and capacity restrictions, particularly in the case of relocation *within* Germany. However, in spite of these tendencies for globalized sourcing, regional and national suppliers remain the most important. As Table 13 shows, even in the case of large firms two-thirds of suppliers are located in Germany. The distribution across sectors shows noteworthy differences: in the “intermediary products” sector, 81% of suppliers are located in Germany, and in the “production goods” sector, this percentage rises to 84, and even to 87 in the “agricultural goods, food” sector, while it falls to 75% for consumer goods.

Table 13 – Germany, location of suppliers by firm size

Location of suppliers	Number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
	in percent				
Close to firm (about 30km maximum distance)	25	20	14	12	18
Outside this "inner circle", but in the same Land	21	22	21	14	21
Outside the Land, but elsewhere in Germany	40	43	43	40	42
Total Germany	*86*	*85*	*78*	*66*	*81*
Outside Germany, but in the EU	7	10	15	20	12
Outside the EU, but in Europe	1	2	2	3	2
Outside Europe	7	3	5	10	5

Source: 2005 DLR survey

Customer side

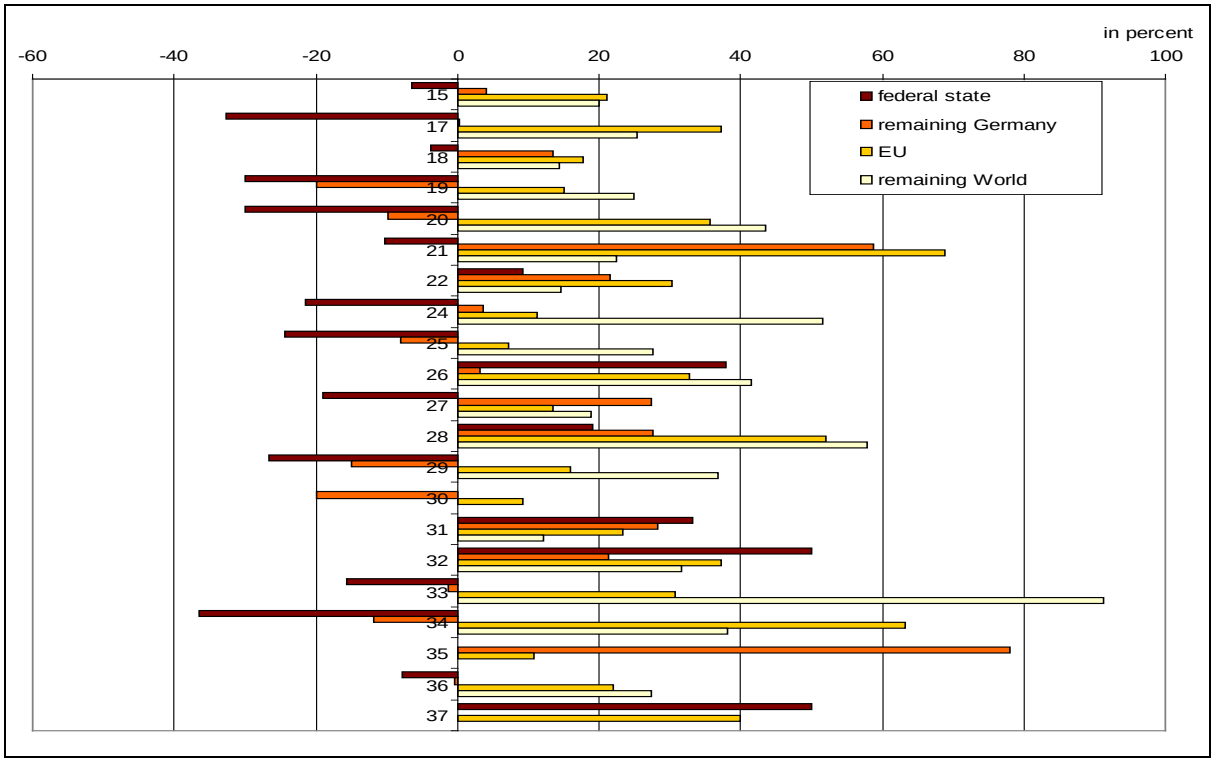
There is a general trend for the number of firms' customers to rise, if one compares the situation at the time of the survey to that five years before. On average, large firms in particular had significantly more customers in 2004 than in 1999. One reason for this increase is that the share of firms with 10,000 customers or more rose from 14% in 1999 to 17% in 2004. The median, however, for the firms with 500 employees and over was 500 in 2004 (Table 14). Overall, the median, which indicates the line that divides the number of firms into two equal parts, was considerably higher in 2004 than five years before. This applies to all enterprise size classes except those with between 1 and 19 employees.

Table 14 – Germany, customers by firm size, 2004 compared to "five years before"

number of customers	number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
	median				
"today"	180	180	250	500	200
"five years ago"	180	150	200	400	200

Source: 2005 DLR survey

Beyond the sheer increase in numbers of customers we find that the regional embeddedness of firms on both the supplier and the customer side has decreased considerably in favour of the European and global level. In detail, the figures show that regional *sales* of industrial products have fallen considerably during the last 10 years. The geographic target area of sales has shifted to the European level or even beyond in almost all sectors (Figure 10). The importance of the European and overseas markets has clearly increased in recent years.



15 Manufacture of food products and beverages
17 Manufacture of textiles
18 Manufacture of wearing apparel; dressing and dyeing of fur
19 Tanning and dressing of leather; manufacture of luggage etc.
20 Manufacture of wood and of products of wood and cork etc.
21 Manufacture of pulp, paper and paper products
22 Publishing, printing and reproduction of recorded media
24 Manufacture of chemicals and chemical products
25 Manufacture of rubber and plastic products
26 Manufacture of other non-metallic mineral products
27 Manufacture of basic metals
28 Manufacture of fabricated metal products etc.
29 Manufacture of machinery and equipment
30 Manufacture of office machinery and computers
31 Manufacture of electrical machinery and apparatus n.e.c.
32 Manufacture of radio, television and communication equipment etc.
33 Manufacture of medical, precision and optical instruments etc.
34 Manufacture of motor vehicles, trailers and semi-trailers
35 Manufacture of other transport equipment
36 Manufacture of furniture; manufacturing n.e.c.
37 Recycling

Figure 10 – Germany, Decrease and increase of the importance of markets between 1995 and 2005 (in % of sales modification, by NACE Classification). Lenz, Menge 2009

4.2.2 France

The French survey was primarily concerned with the relations between sites and their clients. In addition, the questions are not formulated in the same way. Here, we are no longer interested in the location of customers but rather in the configuration of market areas expressed in a percentage of annual tonnages shipped.

Table 15 – France, number of customers and regional scale of market areas by firm size

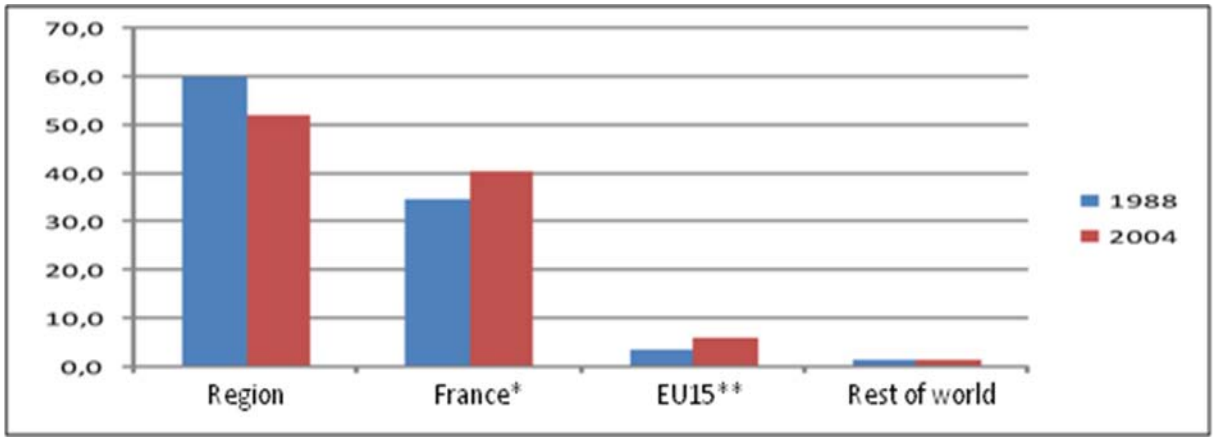
Number of employees	Location (% of mean annual tonnages shipped)			
	Region	Rest of France	Rest of Europe	Rest of world
10 to 19	42%	50%	6%	2%
20 to 49	41%	48%	9%	4%
50 to 499	27%	50%	18%	7%
≥ 500	9%	48%	35%	12%
All	37%	49%	11%	4%

Source: Inrets, 2004 ECHO survey, all manufacturing industries

Our analysis of market areas in tonnages (Table 15) shows that the enterprises are highly embedded in their region: 38% of the tonnages they report shipping are to destinations within their region and 49% to destinations in the rest of the country. These industrial sites have a mean export rate of 15% in tonnage terms, with considerable variations between different sectors. On average, industry exports more than wholesale traders (15% versus 9%) and within industry the highest rates are found for the chemical industry (30%), motor vehicle manufacturing (24%) and the textile and clothing industries (23%). Furthermore, the effect of size is extremely marked, with rates ranging from 8% for the smallest sites with between 10 and 19 employees to 47% for the largest sites with 500 employees and more.

For methodological reasons, it is unfortunately not possible to make comparisons with the earlier 1988 survey as the firms were asked questions in a different way. However, it is quite possible to observe changes not on the basis of shippers' statements, but on the basis of the analysis of the shipments covered in the surveys. One of the original features of the French 1988 Shipper and 2004 ECHO surveys is that they monitored shipments from door to door from the shipper to the final recipient which means both the geographical destinations and distances involved are available.

The results for this population of consignments are presented below for the entire scope of the ECHO survey (both manufacturing industry and wholesale traders). In particular, they confirm the importance of the regional and national markets for firms: 48% of the shipments sent in 2004 were to destinations within the same region and 93% remained within the national borders. Figure 11 nevertheless shows that market areas have grown, with the transfer of some intra-regional shipments to national and European destinations. The effect of European integration is very striking in relative terms, although in absolute terms it involves a smaller number of shipments.



*apart from intra-regional, **apart from national

Figure 11 – France, the geographical destination of shipments (%). Guilbault, Soppé (2009). 1988 Shippers survey and 2004 ECHO survey (with the 1988 scope including wholesale traders).

5. A MICRO-ECONOMIC APPROACH: LOGISTICAL CHANGES IN ENTERPRISES

The German survey reflects above all the way firms organise their cooperation with other firms, which includes, of course, aspects of how they organise business inside the firm. Based on this survey, we will demonstrate how the observations made for the national level are rooted in structures and changes that characterise individual firms, depending on their size, their products and their integration within production networks. To understand the structure of the firms, we will start by exploring their size and turnover in relation to the branch they belong to, their production programmes in terms of the variety of products and turnover, and the variety of inputs they need for their production. We shall then analyze, based on the DLR survey and indicators from the ECHO survey, the importance of Just-in-time activities with other firms. With regard to firms' transport organisation and demand we will look more closely at transport modes, truck frequencies for deliveries and shipments, in particular with respect to the impact of JIT on transport demand and transport volumes, and the share of transport costs in total production costs.

5.1 Structure of the investigated firms and variety of products in the firm

5.1.1Structure of the investigated firms

As we have seen above, the sample of the German survey is concentrated on firms in the production sector, which can be divided into the sub-sectors "intermediary goods", "production goods", "agricultural goods and food" and "consumer goods". To reproduce the structures of these sub-sectors and the firm sizes within them the data set was weighted. Table 16 shows how the firms were distributed in the sample once this has been done.

Table 16 – Structure of firms by size and sector of activity in the DLR survey

Firm size by number of employees	sector of firm activities				
	Intermediary goods	production goods	agricultural goods and food	consumer goods	total
	in absolute figures				
1 to 19	24	33	19	55	131
20 to 49	83	135	19	98	334
50 to 499	102	158	42	98	400
500 +	11	16	2	13	42
total	220	341	82	263	907
share on total sample (weighted)	24,2%	37,6%	9,1%	29,0%	100,0%

Source: 2005 DLR survey

5.1.2 Variety of products produced in the firm

The firms not only differ in terms of size and economic sector, but also in the nature of their production activities. While there is a general trend for larger firms to produce more product groups (Table 17), diversified production is present to varying degrees in all size classes.

Table 17 - Number of product groups by firm size

Number of product groups	Number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
	in percent				
1	40	29	26	28	29
2	20	23	16	17	19
3	13	15	16	12	15
Share of firms producing 1 to 3 product groups	*73*	*67*	*58*	*57*	*63*

Source: 2005 DLR survey

While the overall average is 15.2 product groups per firm, the average for small firms (1 to 19 employees) is only 6.4 product groups. The highest diversity in terms of product groups can be found in firms with between 50 and 499 employees. However, across all firm sizes the two largest product groups account for more than 80% of turnover in the surveyed firms (Table 18). This might support the argument that increasing division of labour goes hand in hand with specialisation. Yet it should be kept in mind that the data do not allow us to perceive temporal changes. While we can observe some differences between firms on the basis of their size, there are no significant differences if we consider the branch to which they belong.

Table 18 - Share of the three most important product groups in total sales by firm size

Share of product group in total sales	Number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
	Average shares in percent				
product group 1	74,1	65,9	64,6	67,4	66,6
product group 2	24,0	25,7	24,6	24,8	25,0
product group 3	12,7	16,7	14,9	13,3	15,2

Source: 2005 DLR survey

5.1.3 Inputs to production

There is no uniform tendency with respect to the number of products that firms purchase as inputs to their production (Table 19). Comparing the firms' statements for 2004, the year of the survey, and "five years ago", we find that SMEs with between 20 and 499 employees have increased their number of inputs, while there has been a massive decrease among large firms. This may be interpreted as showing increasing specialisation among SMEs and an increase in modular production with larger firms. Analysis on the basis of production sectors supports this argument – at least to some degree – with low rates of increase for production goods and even decreasing rates for consumer goods (Table 20).

Table 19 - Number of products needed as input to a firm's own production

Number of employees				
1 to 19	20 to 49	50 to 499	500+	all firms
increase / decrease of "input products" between 1999 and 2004				
- 4 %	+ 7 %	+ 8 %	- 30 %	+ 3 %

Source: 2005 DLR survey

Table 20 - Number of products needed as input to a firm's own production

intermediary products	production goods	agricultural products and food	consumer products	total
increase / decrease of "input products" between 1999 and 2004				
+ 66 %	+ 1 %	+ 23 %	- 12 %	+ 3

Source: 2005 DLR survey

5.2 Application of Just-in-time concepts

Time plays a crucial role for improving productivity, reducing costs and increasing flexibility. This is expressed in concepts like "Just-in-time" (JIT). The delivery of semi-finished products to production lines at the very moment of their processing drastically reduces the need for high-cost buffer and inventory stocks. Introduced initially in automobile production, the JIT concept has been implemented in many industrial sectors, although is not necessarily implemented in the same way. The time span between delivery and processing may vary from one hour to one or even two days. In practice, the term JIT covers a great number of different strategies for shortening and optimising delivery times.

Only 35% of the companies do not use Just-in-time at all. When asked about their relationship with suppliers and customers, more than a third reported that some of their suppliers had to deliver JIT. 9% specified that all their suppliers had to do so (cf. Figure 12). Concerning their role as a supplier the proportion of companies delivering JIT is even larger.

Here, 43% of companies reported having to supply some of their customers Just-in-time. An additional 14% even reported having to supply *all* their customers Just-in-time.

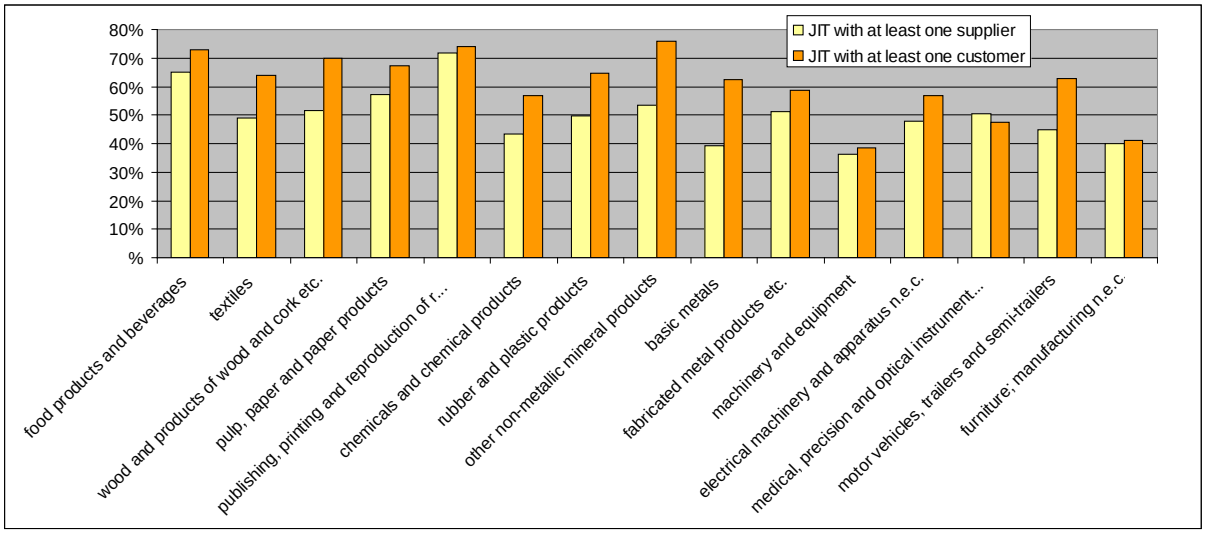


Figure 12 - JIT use according to the economic section
Source: Lenz, Menge 2009 (reduced to cases with at least 20 respondents)

Figure 12 reveals the differences in JIT application depending on the economic sector. It is interesting to note that most firms report that their customers require them to apply JIT more than they require their suppliers to do so. The branches for which JIT is particularly demanded on the supplier side are ‘office machinery and computers’, ‘manufacture of medical and precision instruments’ and ‘other transport equipment’. Overall, we estimate that production downstream the value chain requires more JIT than upstream production. Upstream production, which for example makes intensive use of raw materials – is obviously less JIT intensive. The situation is different for intermediate goods for which the demand for JIT is much stronger. Intermediate goods have to be delivered JIT to the manufacturing customer to be further processed in the value chain.

Besides, it should be kept in mind that JIT is not suitable for every production structure. It is mainly large-scale production that needs to be supplied with a steady and predictable flow of intermediary goods in order to make direct and demand-driven deliveries. Small-scale production with sporadic and unpredictable supply intervals tends to make more use of storage.

Independently of JIT application firms report that production schedules have become tighter in the last ten years. On average, firms across all sizes and branches estimate that the time taken to produce a specific product has been cut by a third. This has naturally led to a reduction in warehousing times too.

The increase in Just-in-time practices is also a major phenomenon in France. The indicators that are available from the ECHO survey to show this change highlight the very considerable reduction that has taken place in average storage times. Data from the 1988 and 2004

surveys show that the number of days of production firms held in advance fell, on average, from 32 to 19 days, i.e. a reduction of 40%. This is a general trend and is apparent for all the sectors of activity and firms of all sizes, with the firms that have gone furthest in applying the Just-in-time principle being agrifood producers (16 days on average) and major firms with 1,000 and more employees (12 days on average).

The proportion of all tonnages that are produced in response to an order is another significant indicator for company decisions about the management of flows and the pressure applied from downstream where demand initiates the production process. The figures, which only relate to 2004, show that this practice is highly dominant in industry. On average, 73% of production is to order and half of the sites produce 90% or more of their tonnages to order. This percentage is relatively uniform throughout all sectors of activity, except for agrifood goods, which are often affected by specific production constraints due to the seasonality and the perishability of products and for which the distribution between firms producing essentially in response to an order or essentially on the basis of stock is more in balance (49% to order and 51% according to stocks).

6. TRANSPORT DEMAND AND TRANSPORT ORGANISATION

6.1 Germany

6.1.1 Use of transport modes

Table 21 – Mode shares of deliveries in the investigated firms by firm size

Share of mode in terms of tonnes transported from the firm to other firms	Number of employees				
	1 to 19	20 to 49	50 to 499	500+	all firms
	Percentage of average shares				
Truck	97	96	94	86	94
Railway	1	1	1	4	1
Inland waterways	0	0	1	1	1
Maritime shipping	2	2	2	5	2
Air	0	1	2	3	2
	100	100	100	100	100

Source: 2005 DLR survey

As we can see from Table 21 the truck is by far the most important transport mode for deliveries in the case of firms in the production sector. However the table also highlights the fact that the larger the firm the more multimodal it becomes. If we consider firms on the basis of their sector of activity, the highest railway shares can be found in the intermediary goods production sector (3%). The highest share of maritime shipping is found in the consumer goods sector (4%). Airfreight plays some role in the case of both production goods and consumer goods (2% in both cases). The picture remains fairly similar for shipments from the firm to its customers, but we can observe that maritime and air transport gain importance in the case of large firms (500 employees or more) and the production goods sector as a whole.

Very often, the JIT concept is considered to be responsible for smaller consignment sizes, as minimization of buffer and inventory stocks reduces purchase order quantities which, in turn, increases the supply frequency. The survey data definitely illustrates this effect. Table 22 shows the number of trucks unloaded versus the number of trucks loaded per day by firms according to whether they use JIT or not. It reveals at least that the volume of freight transport by truck is smaller for those firms that do not work with JIT. It has to be taken into account, however, that these data can only represent a tendency as there are no statistically significant differences between firms with and without Just-in-time if a significance test is run by firm size.

Table 22 - Trucks loaded and unloaded with and without JIT application, by firm size

Firm size by number of employees	Type of JIT / no JIT	Number of trucks loaded per day	Number of trucks unloaded per day
		average	
1 to 19	all suppliers & all customers	3,0	1,7
	no JIT	1,8	2,3
20 to 49	all suppliers & all customers	4,9	5,8
	no JIT	4,7	7,6
50 to 499	all suppliers & all customers	18,8	10,2
	no JIT	8,4	7,6
500 and more	all suppliers & all customers	54,5	18,2
	no JIT	15,7	11,9

Source: 2005 DLR survey

6.1.2 Transport costs

For the vast majority of firms, transport costs do not account for more than 10 % of the total production cost (Table 23). There are, however, quite large differences between sectors. While the highest share of firms whose transport costs amount to a relatively low percentage of production costs are to be found in the “production goods” sector, transport costs account for a particularly high percentage of production costs in the “agricultural goods and food” sector. Obviously this is due the relatively low value-to-weight ratio for this sector.

Table 23 - Share of transport costs in total production costs by economic sector

Share of transport costs in total production costs	Economic sector				
	Intermediary goods	Production goods	Agricultural goods and food	Consumer goods	All firms
	in percent				
Up to 10 %	79	88	64	84	82
11 to 20 %	12	4	24	10	9
More than 20 %	9	8	12	6	9

Source: 2005 DLR survey

6.2 France

6.2.1 The spatial and temporal fragmentation and weight of shipments

The changes described above have resulted in a fragmentation of the economic fabric as a result of the growing proportion of small and medium-sized enterprises and an increase in the division of work between different enterprises. The ensuing splitting up of transport flows is not only spatial but also temporal. The flexibility that is required today of firms and Just-in-time practices result in an increase in shipment frequencies and a reduction in unitary shipment weights. The figures from the ECHO survey show that the mean weight of the shipments sent by firms (before consolidation by transport undertakings) is far below the level of a full load, even in the case of truck transport: an average of 2 tonnes for all the industrial sites covered by the survey and 1.3 tonnes for all the industrial sites and wholesale traders. These shipment weights are also subject to a high degree of dispersion as half the shipments sent by industry weigh less than 86 kg. For industry and wholesale trading together, the median weight is only 30kg and we have observed that this weight has fallen considerably in recent years, from 185 kg to 35kg for the common scope of the 1988 Shipper and 2004 ECHO surveys (Guilbault, 2009).

6.2.2 Shippers' characteristics versus modal solutions

Table 24 - Weakness of road-alternative solutions

Modal solution	% Sites	% Tonnes	% Shipments
Haulage alone			
- Industry	66%	43%	47%
- Wholesale traders	76%	65%	84%
- All	70%	53%	70%
+ maritime/air transport			
- Industry	26%	18%	41%
- Wholesale traders	17%	10%	13%
- All	23%	14%	23%
+ other inland mode			
- Industry	7%	39%	12%
- Wholesale traders	7%	25%	4%
- All	7%	33%	7%

Inrets, 2004 ECHO survey

The results also show an important degree of inertia in the use of transport modes, 70% of all shippers use road haulage exclusively (Table 24). 23% of shippers use road haulage with maritime or air transport, but this kind of modal diversification is mostly made compulsory by overseas exports and has nothing to do with the choice of un alternative solution. Only 7% of shippers reported using rail transport, rail-road combined transport or inland river transport "occasionally". Sustainable inland transport is used by few "hard-core" shippers who generate 7% of all shipments and 30% of all tonnages.

7. CONCLUSION: RELATION OF STRUCTURE, NETWORK INTEGRATION AND TRANSPORT DEMAND

The analyses conducted in the two countries show that major economic changes are at work. These macroeconomic changes, such as the rapid growth in international trade – more marked in the case of German exports -, or deindustrialisation in France and the weakness or disappearance of the largest firms are obviously linked to the internal organization of firms.

The shippers'surveys conducted by Inrets and the DLR in the two countries have allowed us to quantify the influence of these major trends on the internal organization of firms and their transport practices. Deindustrialisation in France, which has been to the benefit of services with a large number of intermediaries in their production and distribution channels and the shift of German industry towards production with higher value added have encouraged the implementation of Just-in-time practices in firms. "Just-in-time" tends to lead to shipments that are more frequent and smaller, for which road transport is preferred on the grounds of flexibility, and the abandonment of consolidated modes such as the railways or waterways.

The fragmentation of the economic fabric and the increasing proportion of small and medium-sized firms are an important structural factor with regard to transport, and in this connection we have demonstrated very clear links between the size of a site and the transport solutions it chooses. The larger the site, the more flows it generates (in volume), the heavier its shipments and the more it tends to use consolidated modes. The effect of this tendency is amplified by the small proportion of large firms. The reduction in the number of large firms in France is correlated with the drastic drop in rail transport. These surveys also reveal that the opening up of borders and the development of outsourcing are a major factor of development, particularly in the case of Germany. The division of labour has become more globalized and production times have become shorter. However, it is remarkable at the same time that for both countries the national and even regional context remains by far the most important for firms' production.

If we compare the situations in France and Germany, we can conclude in a more general fashion that in spite of differences in their economic macrostructures, the production sectors of both are undergoing very similar changes. Production times are becoming shorter, there is less warehousing and/or reduced warehousing times, an increase in transport demand, and a shift towards road transport. All this confirms the "trickling down" of macro trends to the level of the firm, although differentiation at a micro level is also apparent from the national results and our comparisons. Shipper surveys of this type are therefore essential in order to analyze production constraints and gain an understanding of, for example, the factors that hinder modal transfer.

This research highlights the potential there may be to bring about a change in transport practices and its organization by modifying models of production. It also shows the value of a study that is conducted both at the macroeconomic level and at the level of individual firms.

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